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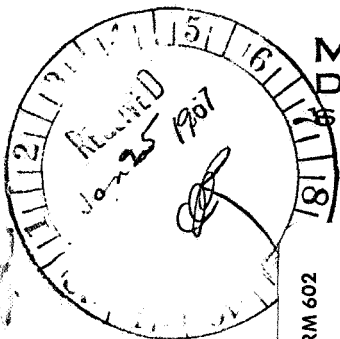
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BONDED SEGMENTED BULKHEAD

(DA-103) TEST PLAN

10 January 1967

DAC-60554



MISSILE & SPACE SYSTEMS DIVISION
DOUGLAS AIRCRAFT COMPANY, INC.
SANTA MONICA/CALIFORNIA

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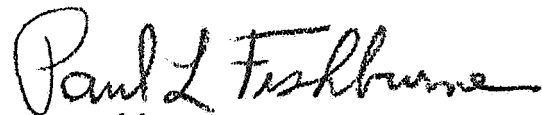
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J. W. Kidd

Bonded Segmented Bulkhead (DA-103)
Test Plan

10 January 1967
Douglas Report No. DAC-60554

Prepared for
National Aeronautics and Space Administration
George C. Marshall Space Flight Center
Huntsville, Alabama
Contract No. NAS 8-11648



Approved by
P. L. FISHBURNE, Manager
Segmented Bulkhead Program

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ABSTRACT

This test plan is prepared for the National Aeronautics and Space Administration to present the test program that will be conducted on a full scale, SIV size, research and development type common bulkhead. The objectives of the program are, (1) to determine the structural characteristics of a bulkhead manufactured with a weld-spliced aft facing skin and an adhesive bond-spliced forward facing skin; (2) to verify the structural integrity of the bulkhead under cryogenic and pressure environments; (3) to determine the ultimate capability of the bulkhead with respect to reverse buckling; (4) to determine the leakage of liquid and gaseous hydrogen through the polyurethane cryogenic adhesive; (5) to provide full scale test data from a bulkhead manufactured in this manner for comparison with data obtained from testing of a full scale SIV bulkhead manufactured in the normal manner (weld-spliced forward and aft facing skins). The critical conditions to be tested are those of thermal shock, positive and negative proof, limit and ultimate pressure differentials. In addition to simulated SIV operating conditions, the test plan includes a reverse buckling failure condition to determine ultimate structural capability of the bulkhead. The test article will be instrumented with strain gauges, deflection transducers, temperature sensors, and pressure transducers to provide a maximum amount of test data for design and analysis evaluation, and test control.

The tests are authorized by contract NAS 8-11648 under the sponsorship of the National Aeronautics and Space Administration, George C. Marshall Space Flight Center, Huntsville, Alabama.

Descriptors

Test Plan

Common Bulkhead

Bonded Segmented

Cryogenic

Thermal Shock

Pressure

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1.0 -- INTRODUCTION

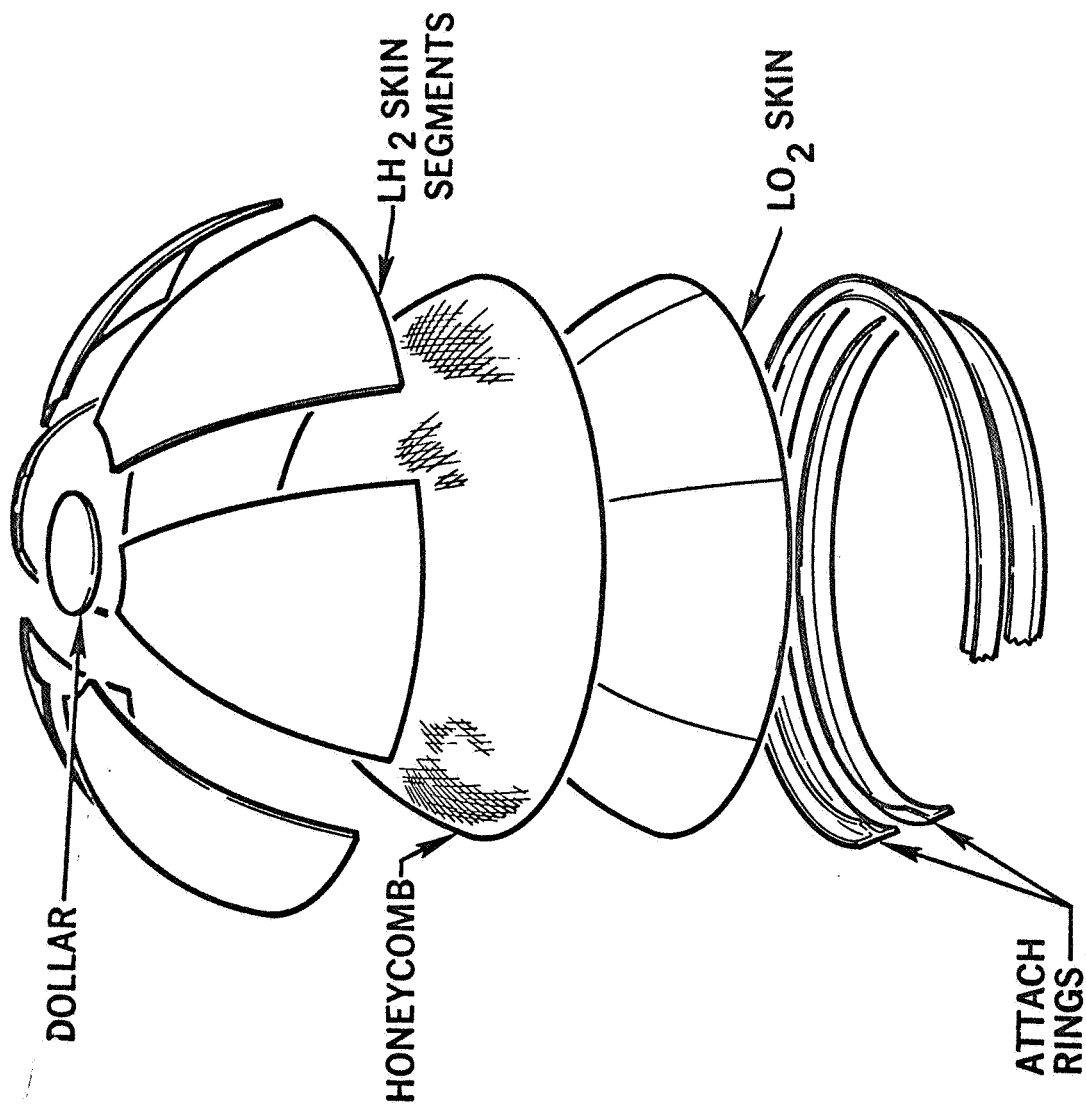
A full scale, S-IV size, common bulkhead (P/N 1T05141) will be tested to verify the structural adequacy of its bonded joints and to determine the capability of the polyurethane adhesive to seal against liquid and gaseous hydrogen from permeating into the core area separating the aft and forward faces. The common bulkhead (Figure 1), a concept which has been employed on both the S-IV and S-IVB stages of the Saturn booster, is a spherical dome shaped barrier separating the liquid hydrogen and liquid oxygen propellant tanks. The common bulkhead - in addition to furnishing a pressure seal between the tanks - provides necessary insulation between the two propellants necessitated by their 125.8°F temperature difference.

The standard S-IV common bulkhead is fabricated from two 2014-T6 aluminum facing skins separated by a one-inch phenolic fiberglass honeycomb core. The forward and aft face sheets are made of six gore segments and center dollar plate welded together by the metallic inert gas (MIG) welding technique. The nominal membrane thicknesses for the forward and aft face sheets are .025 and .047 inch, respectively, with appropriate increase in thickness adjacent to the weld areas.

The common bulkhead to be tested under this plan differs from the above method of manufacture as bonding replaces welds on the forward facing skin. The core is bonded to the previously welded aft skin. The forward skin is bonded to the core as seven separate pieces, six segments plus dollar plate, and subsequently spliced by bonding with .032 and .125 inch thick fingered doublers using a polyurethane-adiprene L adhesive. The adhesive serves both as a structural bond and a seal between the LH₂ tank and the core of the bulkhead. The common bulkhead is welded into an S-IV aft dome (dynamics vehicle) to form the LO₂ tank on the aft side and the LH₂ tank on the forward side.

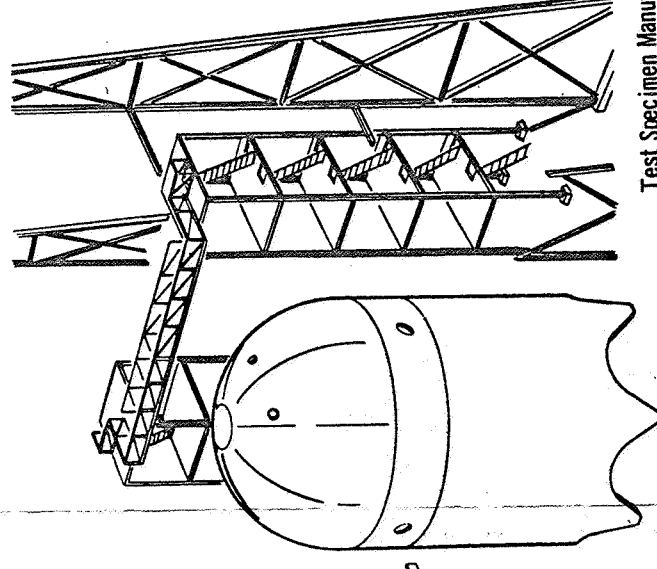
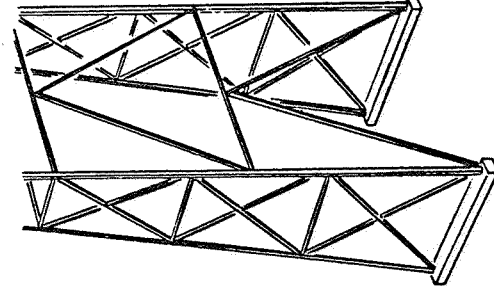
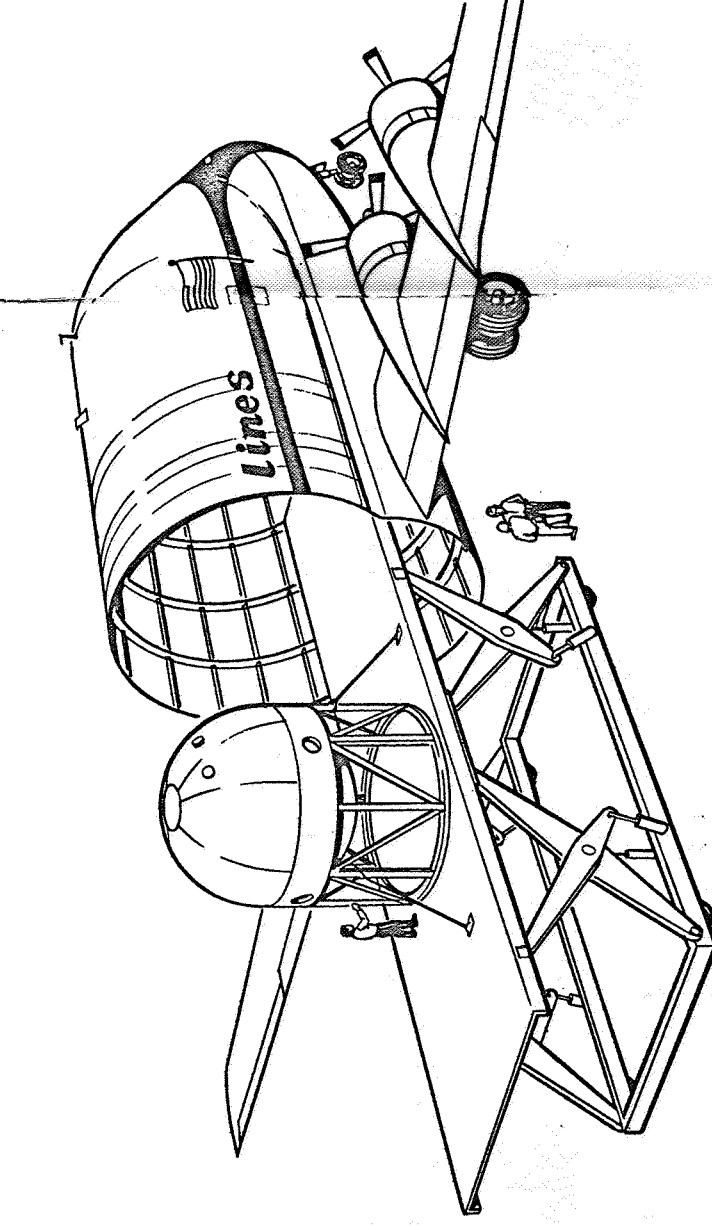
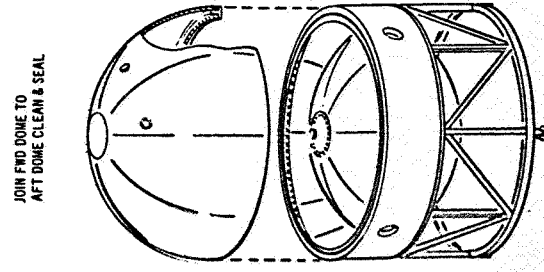
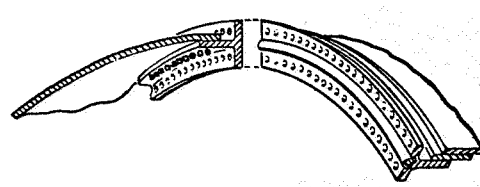
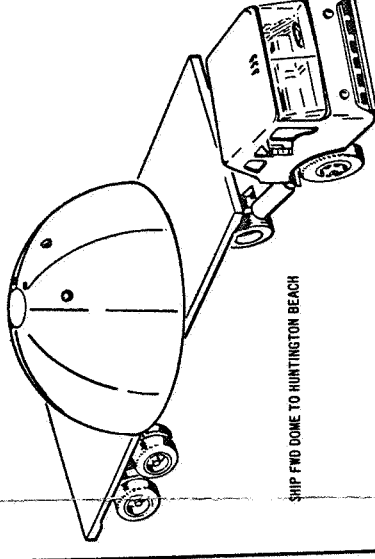
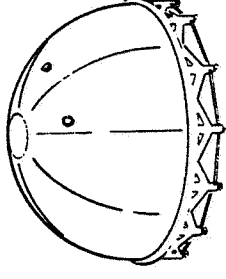
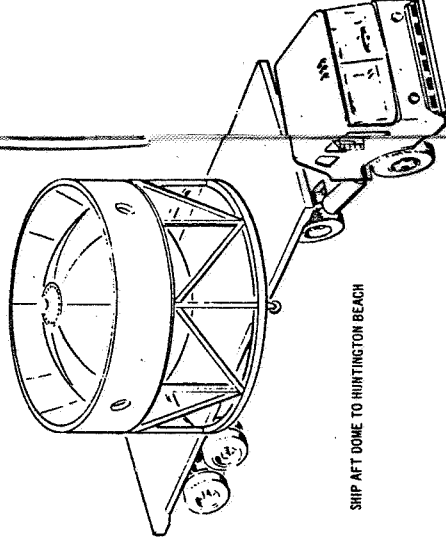
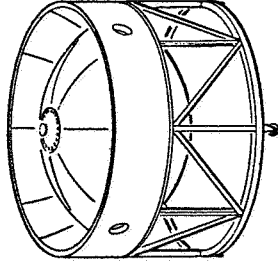
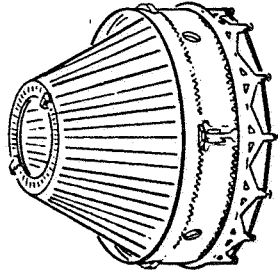
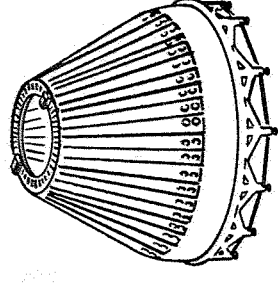
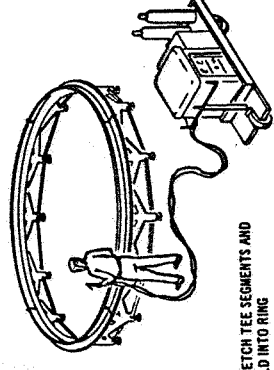
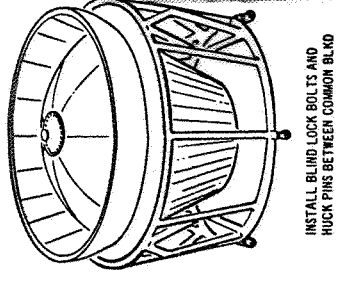
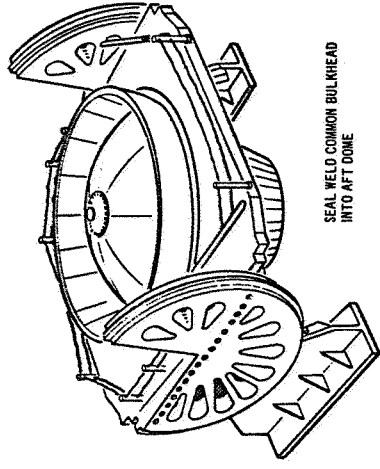
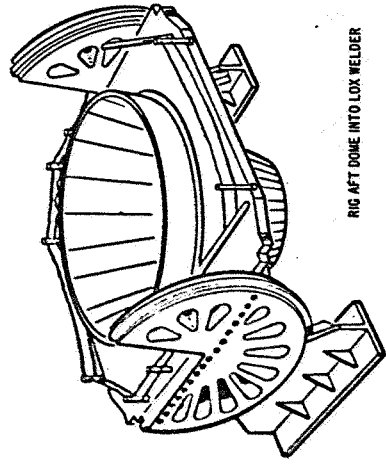
The test article, designated as Douglas Model DA-103, is made from the aft dome of the S-IV dynamics vehicle (P/N 5863805-505), the common bulkhead (P/N 1T05141-1), and a new special forward dome (P/N 1T13686-1) made of .500 inch thick 5086H32 aluminum. The structural modification (Figure 2) consists of heavy "T" rings attached to the aft edge of the forward dome and the forward edge of the aft dome. The two hemispherical domes are bolted together to form the sphere, with the common bulkhead welded and huck-bolted into the aft dome, forming the LH₂ tank on the upper side and the LO₂ (LN₂

M-19559A



NEW BULKHEAD COMPONENTS

Figure 1



used for test) tank on the lower side. The faying surfaces of the rings are sealed with a "Creavy"-type "O" ring seal consisting of a stainless steel wire spring embedded in a teflon tube covering. The arrangement of the specimen on the test pad is shown in schematic form of Figure 3.

The test program is oriented to subject the test specimen to the critical conditions of pressure and temperature predicted for a flight article. To minimize possible safety hazards existing with use of flight propellants, liquid nitrogen is substituted for liquid oxygen.

The test program will consist of the basic critical common bulkhead conditions of LH_2 and simulated LO_2 (LN_2) loading at proof, limit, and ultimate negative and positive pressure differentials, and a failure test with negative pressure (compression buckling) on the bulkhead.

The test specimen fabrication and modification is accomplished at the Santa Monica facility and is shipped to the Huntington Beach facility as two hemispheres to be assembled into the final sphere. It is cleaned, sealed, and shipped to the Sacramento Test center where this test program will be conducted.

2.0 -- TEST AUTHORIZATION

This Research and Development common bulkhead test program is being conducted in accordance with the requirements of the National Aeronautics and Space Administration Contract No. NAS 8-11648, Phase IV and Phase VIII.

3.0 -- TEST OBJECTIVES

The objectives of this test program are:

1. To determine the structural characteristics of the bulkhead in relation to stress distribution, deflections, creep, and moment distribution, and, to compare these data to those obtained from testing a bulkhead manufactured in the normal manner and subjected to identical loading conditions (Ref. DA-105 Test Plan SM-47336).
2. To verify the structural integrity of the bulkhead to withstand thermal and pressure loadings equivalent to those required of a Saturn S-IV flight vehicle.

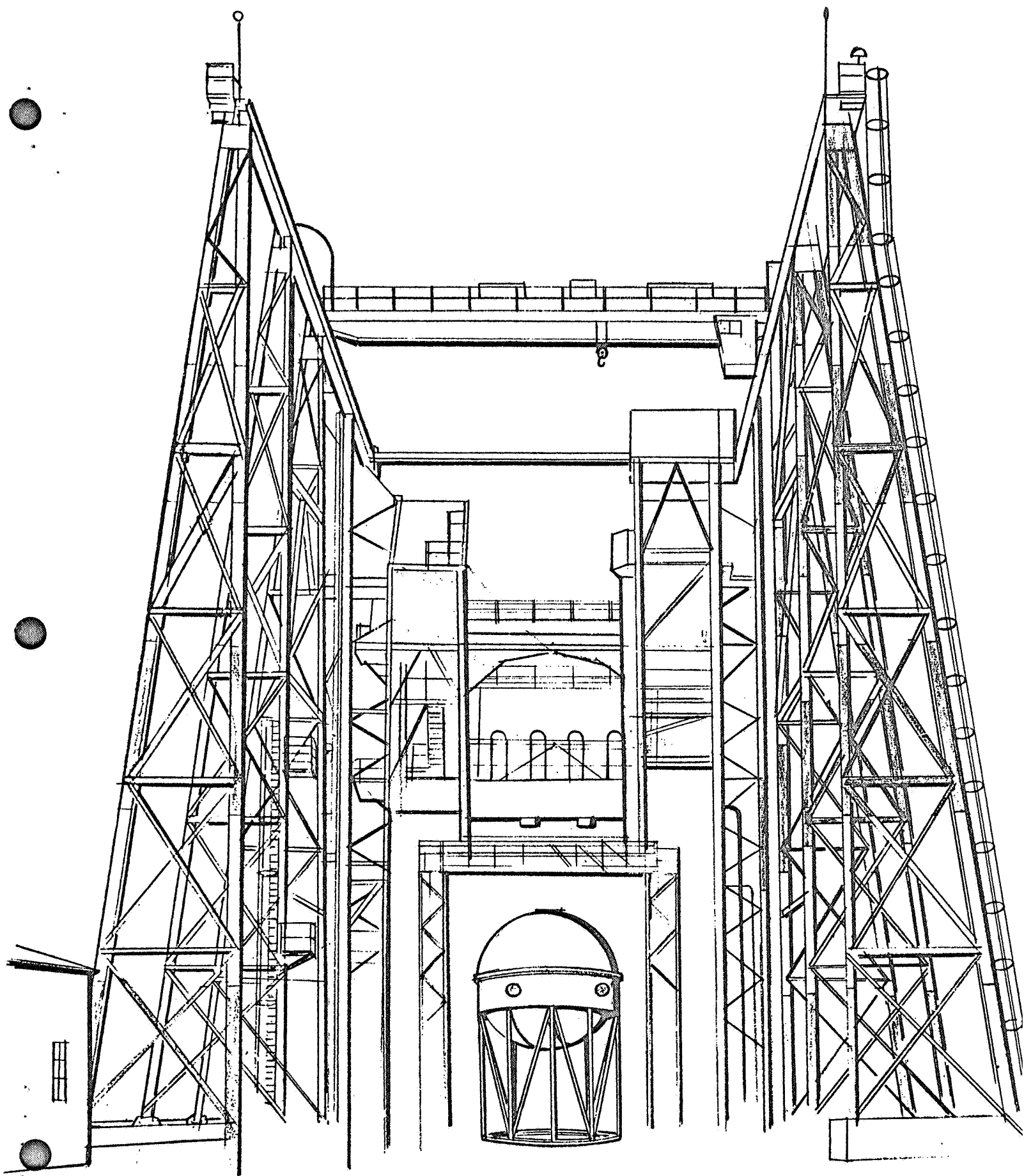


Figure 3

S-IV TEST SPECIMEN IN TEST TOWER

3. To determine the ultimate failure pressure of the bulkhead by reverse buckling.
4. To determine the leakage of liquid hydrogen through the bonded joints of the forward skin, and determine permeability characteristics.
5. To provide full-scale test data obtained from a bonded bulkhead for direct comparison with data obtained from a bulkhead manufactured in a standard manner (welded).

4.0 -- TEST PROGRAM

4.1 -- General

In order to achieve the five objectives of the test program, a series of four separate countdowns will be conducted. Countdown 1 is a pre-test operation associated with establishing the initial specimen structural integrity (proof pressures) and calibration of test instrumentation. Countdowns 2 and 3 will simulate the basic critical bulkhead conditions of LH_2 and simulated LO_2 loading (LN_2) at limit, and ultimate positive and negative pressure differentials. Countdown 4 is to determine the pressure required to produce ultimate failure of the bulkhead by reverse buckling.

4.2 -- Test Pressure and Temperature Criteria

4.2.1 -- Pressures

The LO_2 and LH_2 tank pressures that will be utilized are taken from Reference 2, "DSV4 Propellant Tank Strength Analysis", dated November 1962, revised July 1965. These pressures and temperatures will produce the most critical common bulkhead conditions in conjunction with the temperature gradients across the bulkhead.

During cryogenic loading and draining the limitations on the common bulkhead pressure differentials as specified in Reference 1 shall be in effect.

4.2.2 -- Temperatures

No preconditioning of the specimen tankage with respect to temperature will be required for this test program. Ambient conditions shall prevail

at start of fill and those temperatures gradients obtained during fill and pressurization cycles will represent the most severe cases expected for a flight vehicle.

4.3 -- Basic Ground Rules

Specific items pertinent to all countdown procedures are defined as follows:

1. All test pressures specified for the LH_2 tank apply to the most forward point on the aft side of the forward dome.
2. All test pressures specified for the LO_2 tank apply to the most forward point on the aft face of the common bulkhead.
3. Negative pressures inside either tank shall never exceed 0.36 psid with respect to pressure outside the tanks.
4. For this test program, positive pressure differential is defined as the pressure differential across the common bulkhead when the pressure in the LO_2 tank exceeds the pressure in the LH_2 tank.

$$+ \text{PSID} = P_{\text{LO}_2} > P_{\text{LH}_2}$$

5. For this test program, negative pressure differential is defined as the pressure differential across the common bulkhead when the pressure in the LH_2 tank exceeds the pressure in the LO_2 tank.

$$- \text{PSID} = P_{\text{LO}_2} < P_{\text{LH}_2}$$

6. Prior to any cryogenic loading or testing, there shall be a 99+% nitrogen and a 99+% helium atmosphere in the LO_2 and LH_2 tanks, respectively.

4.4 -- Test Procedures

The test procedures to be followed are outlined in this section. All instrumentation defined in Section 5.0 will be recorded continuously, or at least through fill and drain operations and pressure increase or decrease.

It may be turned off during extended hold periods, as long as the tanks are not pressurized. Continuous recording will commence at the initiation of each countdown and will terminate upon completion of the countdown. During the common bulkhead purging operations (task 4.4.1), the common bulkhead internal pressure shall be recorded manually each hour as described in Section 4.4.1. At the completion of detanking operations for all countdowns involving cryogenics, all strain, deflection, temperature, and pressure data will be recorded for one minute every fifteen minutes until the common bulkhead temperature, as measured at the apex of the common bulkhead on both faces, has returned to approximately -50°F .

Visual monitoring of all liquid level sensor and pressure transducer channels will be conducted during all countdowns. In addition, selected strain and temperature data channels as indicated in Figures 7 and 14 will be recorded on strip charts.

Pressurization and depressurization of tanks during testing at Sacramento shall be performed at a rate not to exceed 1.0 psi every 3 seconds, with a 1-minute hold at midrange of pressure limits and two 1-minute holds at pressures 10 and 5 psi below maximum pressures or maximum differential pressures. These 1-minute holds are to allow recording of data during steady-state conditions.

4.4.1 -- Common Bulkhead Pre-Conditioning

Prior to initiation of any testing at Sacramento, the common bulkhead shall be pre-conditioned and leak-checked using the procedures outlined in this section. The core volume of the common bulkhead will be leak checked while pre-conditioning for testing.

4.4.1.1 - Attach pressure transducers, gauges, gas sample bottles, necessary valves, Argon gas supply, and vacuum pump to each outlet from the bulkhead core volume and pressure transducers to the bulkhead faying cavity outlets (1 each).

4.4.1.2 - With the propellant tanks at or near ambient pressure, evacuate the common bulkhead core for 72 hours. Isolate the core volume and observe the pressure rise during a 48-hour period. Record manually

the absolute pressure each hour during first and second working shifts only. Automatic pressure recordings from the pressure transducers need not be made during this evacuation and pressure rise check.

A 7.0 psi pressure increase in the 48-hour duration is acceptable. If rise is greater than 7.5 psi, engineering will give disposition for a pressure leak check of the bulkhead seams.

4.4.1.3 - Purge the common bulkhead with Argon continuously until the internal pressure is 18 ± 0.5 psi and purged throughout. This is verified by isolating the common bulkhead and monitoring the internal pressure. If the pressure does not decrease, the common bulkhead is completely purged. The gas content of the common bulkhead is verified by taking a gas sample after purging.

4.4.1.4 - The common bulkhead will again be evacuated for 72 hours. The bulkhead will then be isolated and a gas sample taken after the pressure has stabilized and at the time of any significant pressure increase.

4.4.1.5 - The common bulkhead shall remain isolated for the duration of the test program unless the pressure rises above the 4.5 psia with LN_2 and LH_2 in the tanks, 6.5 psia with LN_2 only, or 18 psia without cryogenics. Should the internal pressure exceed these limits, a gas sample shall be taken and vacuum pumping initiated.

4.4.2 -- Countdown 1

Ambient Proof Pressure and Pneumatic Instrumentation Calibration and Gaseous Leak Check.

4.4.2.1 - Proof Loading and Instrumentation Checkout.

4.4.2.1.1 - All Instrumentation must be installed and operating.

4.4.2.1.2 - Pressurize the LO₂ tank with gaseous nitrogen to 35.0 ± 0.5 psia with the LH₂ tank vented. Hold this pressure condition until structure and instrumentation readings are stabilized.

4.4.2.1.3 - Pressurize the LH₂ tank with gaseous helium to 25.0 ± 0.5 psia. Hold until structure and instrumentation readings are stabilized. With LH₂ tank pressurized, slowly vent LO₂ tank to ambient. Hold this pressure condition until structure has stabilized.

4.4.2.1.4 - Vent LH₂ tank. Following the venting of all tankage, the forward dome, aft dome, and common bulkheads shall be visually inspected from the manhole. The 6-meridian welds, dollar plate weld, circumferential weld of bulkhead skin, and the aft toe weld of the bulkhead attach angle shall be die-penetrant inspected after each countdown.

4.4.2.2 - Bubble Leak-check of Forward and Aft Domes and All Closures.

4.4.2.2.1 - Bubble leak-checking may be done prior to or after external insulation installation and before or after proof loading and instrumentation calibrations.

4.4.2.2.2 - All fill, drain, vent, pneumatic, pressurization, and instrumentation pass-through systems must be installed and in operating condition.

4.4.2.2.3 - Purge the LO₂ tank with gaseous nitrogen so atmosphere in tank is 99+% nitrogen. Pressurize LO₂ tank with gaseous nitrogen to 24.7 ± 2.0 psia. Bubble leak check all weld seams, common bulkhead attach bolts, plugged closures and system connections for leaks. Vent tank.

4.4.2.2.4 - Purge LH₂ tank with helium so atmosphere in tank is 99+% helium. Pressurize the tank with helium to 24.7 ± 2.0 psia. Bubble leak-check all weld seams, closures, and systems forward of common bulkhead attachments. Vent the tank to atmospheric pressure.

4.4.2.2.5 - Repair leaks as in accordance with engineering instructions.

NOTE : The common bulkhead has previously been purged with Argon, evacuated and isolated. No additional conditioning should be required at the initiation of each subsequent countdown unless a significant pressure increase is indicated. If such indications during previous testing are obtained, the common bulkhead shall be repurged with Argon, evacuated for 72 hours, and isolated following determination of the cause of the pressure increase.

4.4.3 -- Countdown 2

4.4.3.1 - Condition I. Limit Positive Pressure with cryogenics.

4.4.3.1.1 - The flight loading sequence shall be initiated for loading the LO₂ tank with LN₂. Both tanks shall remain vented during the LO₂ tank fill operation.

4.4.3.1.2 - After filling the LO₂ tank with LN₂, the LO₂ tank shall be pressurized with gaseous nitrogen to 18.0 ± .05 psia. The LH₂ tank shall be vented to atmospheric pressure but purged with helium.

4.4.3.1.3 - Fill LH₂ tank with LH₂ using fill rates approximating those for the flight vehicle within the facility capability.

4.4.3.1.4 - During cryogenic loading, the loading limitations on the common bulkhead pressure differential and the common bulkhead internal pressure in accordance with Reference 1 shall be in effect.

4.4.3.1.5 - Vent the LH₂ tank and pressurize the LO₂ tank with gaseous nitrogen to the limit positive pressure differential applicable for both tanks filled with cryogenics 37.0 ± 0.5 psid, or 51.0 psia in LO₂ tank.

4.4.3.1.6 - Hold this pressure condition for 5 minutes.

4.4.3.2 - Condition II. Limit Negative Pressure with cryogenics.

4.4.3.2.1 - Both tanks are filled with the appropriate cryogenics and the LO₂ tank pressurized to 51 psia from condition I above.

4.4.3.2.2 - Pressurize the LH₂ tank with gaseous helium to 38.3 ± 0.5 psia.

4.4.3.2.3 - Slowly vent the LO₂ tank to ambient, thus obtaining the limit negative pressure differential on the common bulkhead applicable for both tanks filled with cryogenics (-23.8 ± .05 psid).

4.4.3.2.4 - Hold pressure condition for 5 minutes, vent the LH₂ tank to ambient or ≤ 17.5 psia and hold for 5 minutes. Initiate detanking sequence and empty tanks.

4.4.3.2.5 - Inspect LH₂ tank and forward side of common bulkhead from manhole only. Die penetrant inspect welds on aft side of common bulkhead and aft toe weld and visually inspect LO₂ tank for damage.

4.4.4 -- Countdown 3

4.4.4.1 - Condition I - Ultimate Positive Pressure with cryogenics.

4.4.4.1.1 - The flight loading sequence shall be initiated for loading the LO₂ tank with LN₂. Both tanks shall remain vented during the LO₂ tank fill operation.

- 4.4.4.1.2 - After filling the LO₂ tank with LN₂, the LO₂ tank shall be pressurized with gaseous nitrogen to 18.0 ± 0.5 psia. The LH₂ tank shall be vented to atmospheric pressure and purged with gaseous helium.
- 4.4.4.1.3 - The LH₂ tank shall then be filled with LH₂ with the fill rates approximating those for the flight vehicle within the facility capability.
- 4.4.4.1.4 - During cryogenic loading, the loading limitations on the common bulkhead pressure differential and the common bulkhead internal pressure in accordance with Reference 1 shall be in effect.
- 4.4.4.1.5 - Vent the LH₂ tank and pressurize the LO₂ tank to the ultimate positive pressure differential applicable for both tanks filled with cryogenics (50.0 ± 0.5 psid, or 64.0 ± 0.5 psia).
- 4.4.4.1.6 - Hold pressure for 2 minutes maximum.
- 4.4.4.2 - Condition II. Ultimate negative pressure with cryogenics.
- 4.4.4.2.1 - Both tanks are filled with cryogenics and the LO₂ tank pressurized to 64.0 psia from condition above.
- 4.4.4.2.2 - Pressurize the LH₂ tank with gaseous helium to 46.6 ± 0.5 psia.
- 4.4.4.2.3 - Slowly vent the LO₂ tank to ambient pressure, thus obtaining the ultimate negative pressure differential across the common bulkhead applicable for both tanks filled with cryogenics (32.1 ± 0.5 psid).
- 4.4.4.2.4 - Hold this pressure for 2 minutes, then vent the LH₂ tank to ambient pressure. Hold for 5 minutes and initiate detanking sequences.

4.4.4.2.5 - After the tanks have been emptied and purged with appropriate gasses, inspect the LH₂ tank and forward face of the common bulkhead from the manhole only. Die penetrant inspect welds on aft face of common bulkhead and aft toe weld and visually inspect LO₂ tank for damage.

4.4.5 -- Cryogenic Failure Test

4.4.5.1 - The LO₂ tank shall be filled with LN₂. Both tanks shall remain vented during the LO₂ tank fill operation.

4.4.5.2 - After filling the LO₂ tank with LN₂, pressurize the tank with gaseous nitrogen to 18.0 ± 0.5 psia; the LH₂ tank being vented to ambient pressure and purged with helium.

4.4.5.3 - Fill the LH₂ tank with LH₂, then vent the LO₂ tank to ambient pressure.

4.4.5.4 - Pressurize the LH₂ tank until failure of the common bulkhead. All tanks shall be vented as soon as possible after failure.

5.0 -- INSTRUMENTATION

Strain, deflection, temperature, pressure, and level sensor instrumentation utilized in this test program are shown in figures 4 through 15 .

6.0 -- TEST EVALUATION AND DOCUMENTATION

6.1 -- Evaluation Approach

An outline of the principal steps which will be taken in the test evaluation for each of the test objectives in Section 3.0 is presented to establish a logical and sequential approach to the evaluation. However, a maximum amount of flexibility will be maintained to permit such deviations from this outline that will improve on the quality and completeness of evaluation as the test progresses and the final test evaluation.

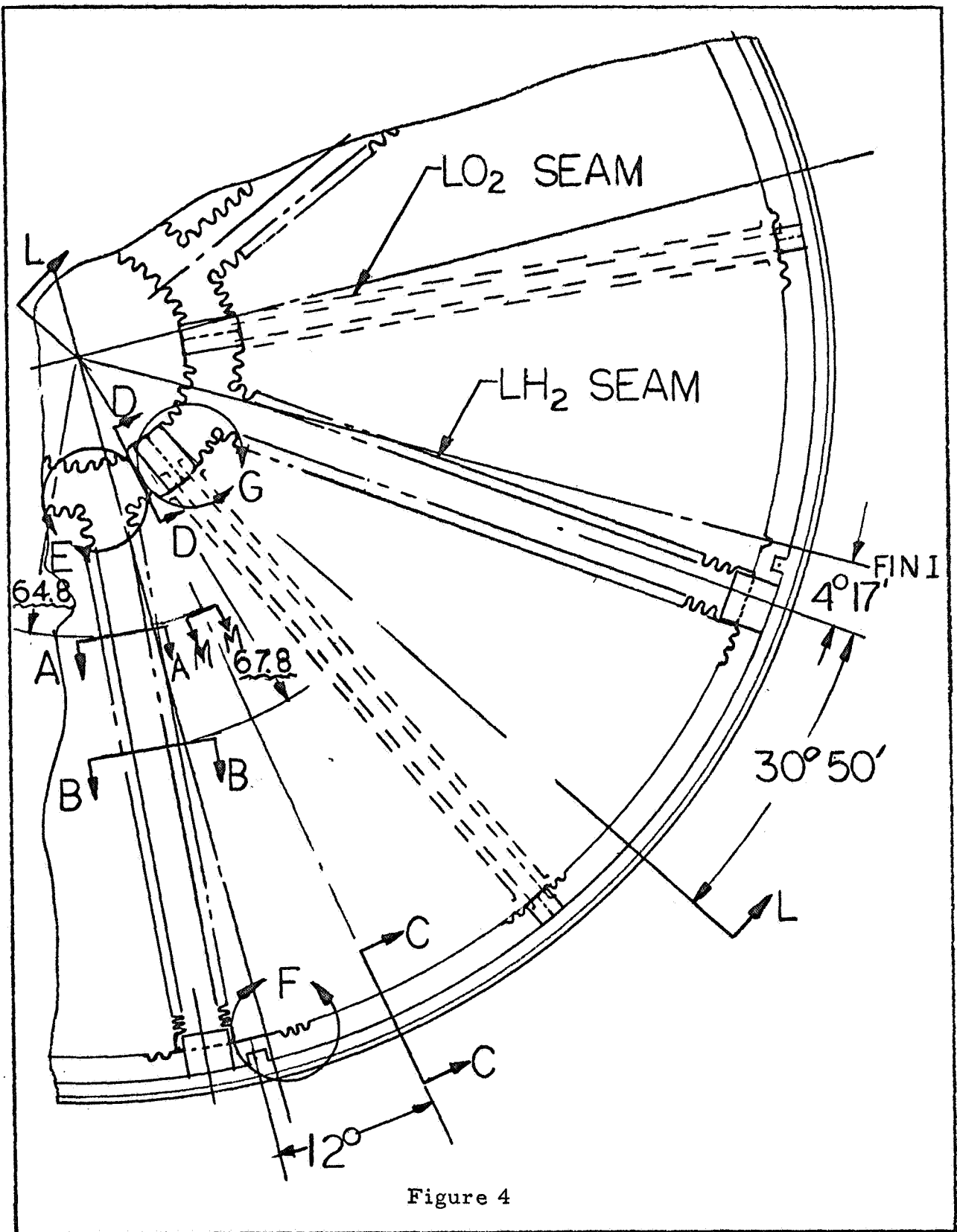
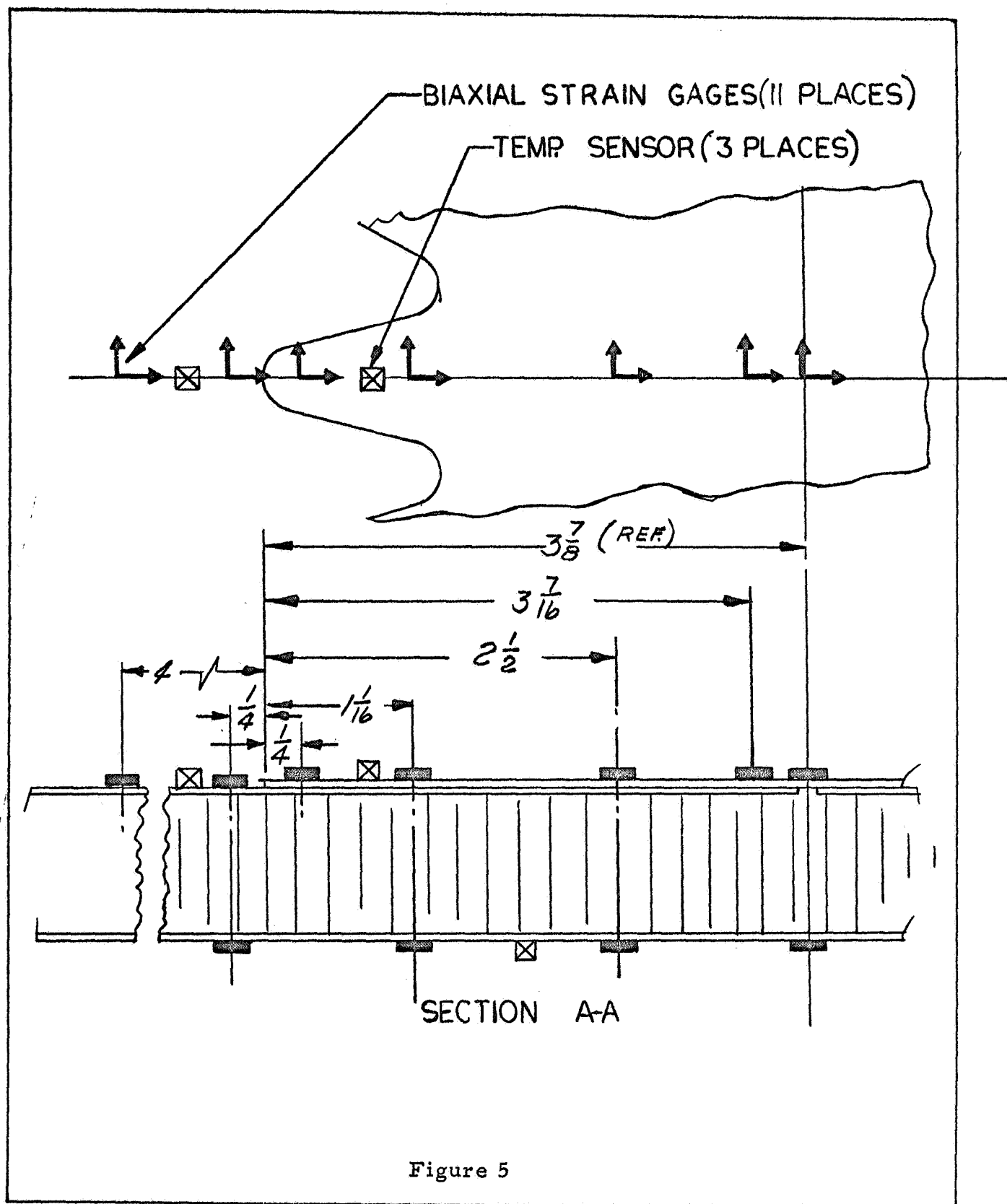


Figure 4

BONDED
COMMON BULKHEAD
VIEW LOOKING AFT



STRAIN GAGES
TYPICAL MERIDIAN SPLICE

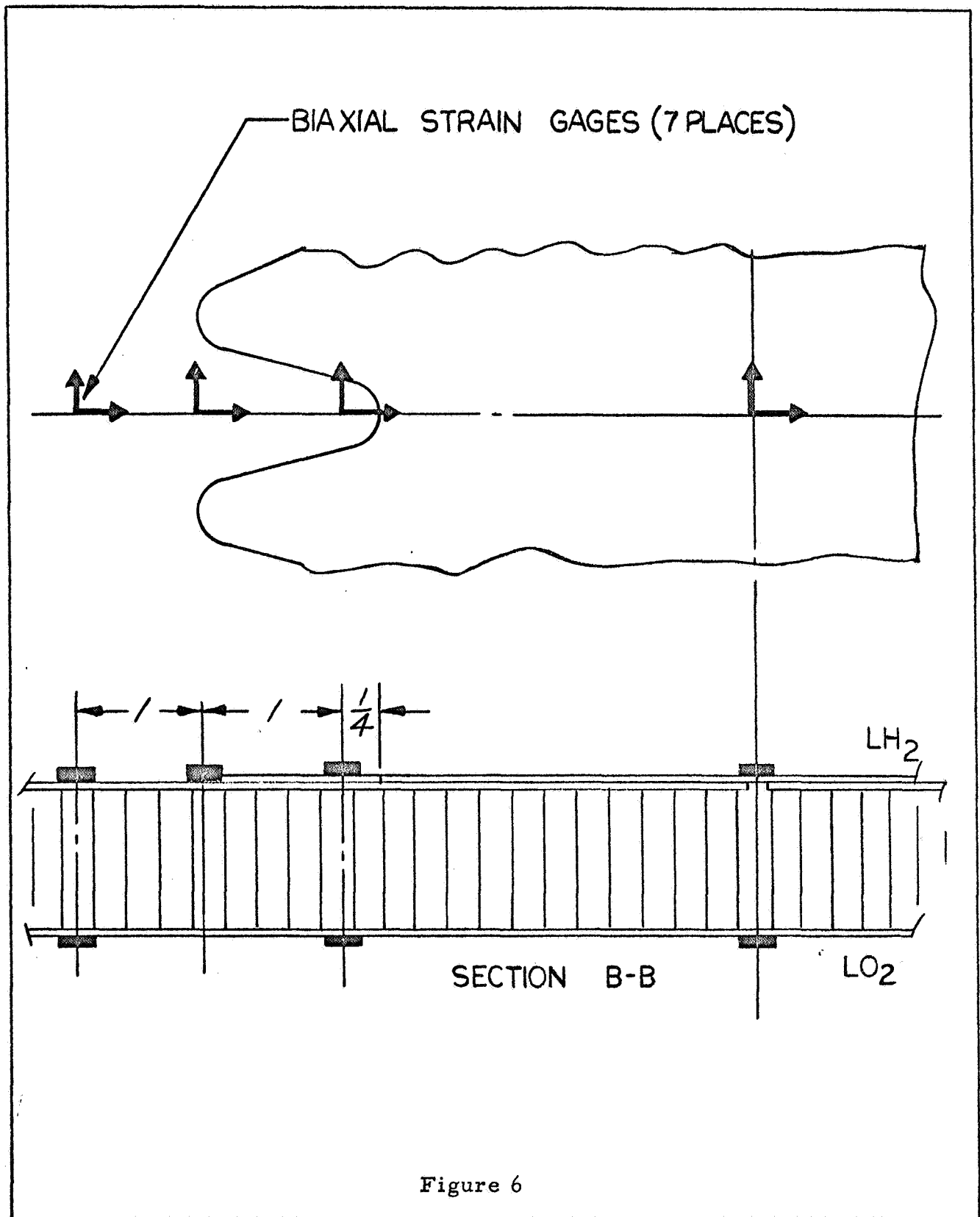
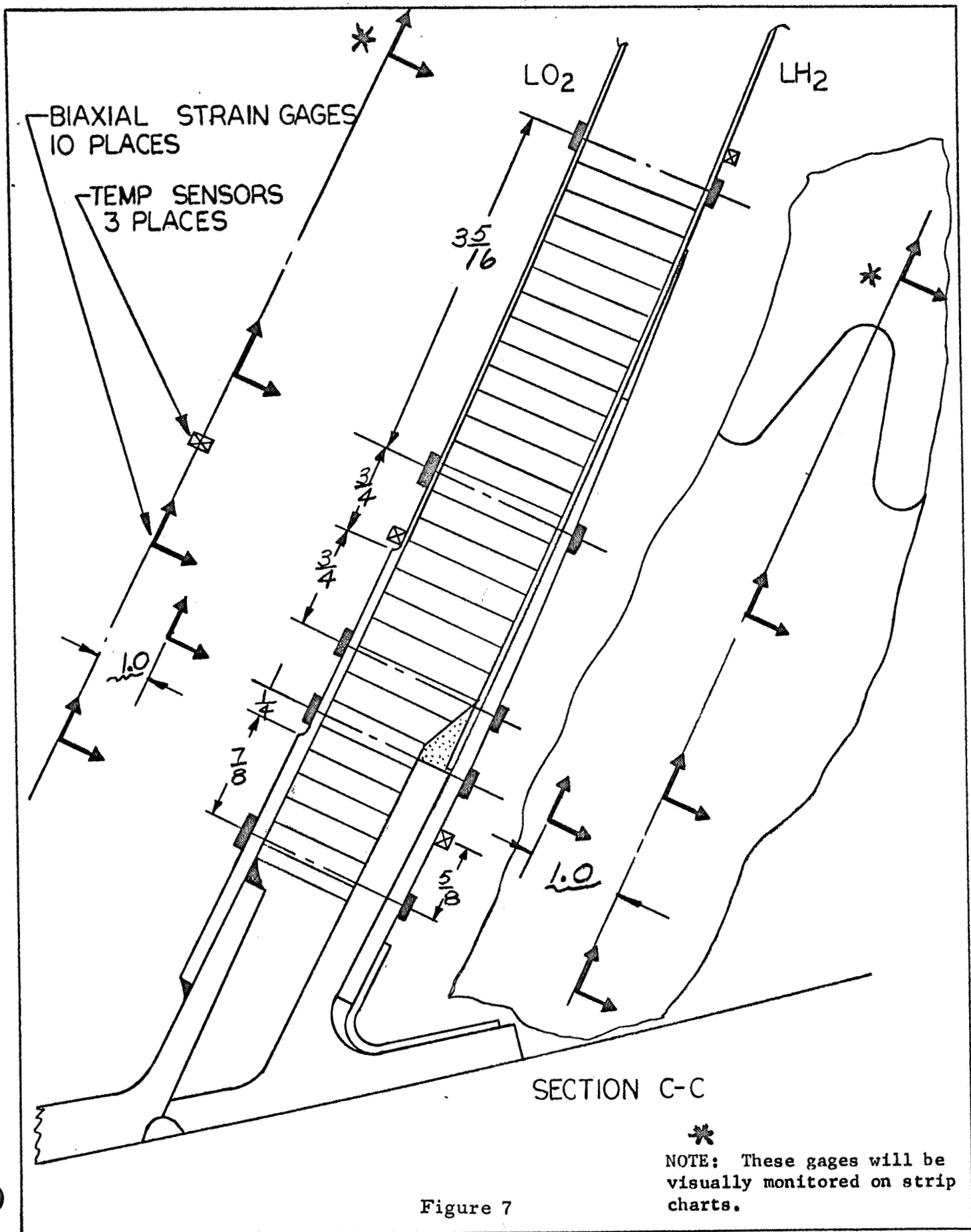


Figure 6

STRAIN GAGES
TYPICAL MERIDIAN SPLICE



STRAIN AND TEMPERATURE INSTRUMENTATION ON
COMMON BULKHEAD NEAR BULKHEAD - TANK JOINT

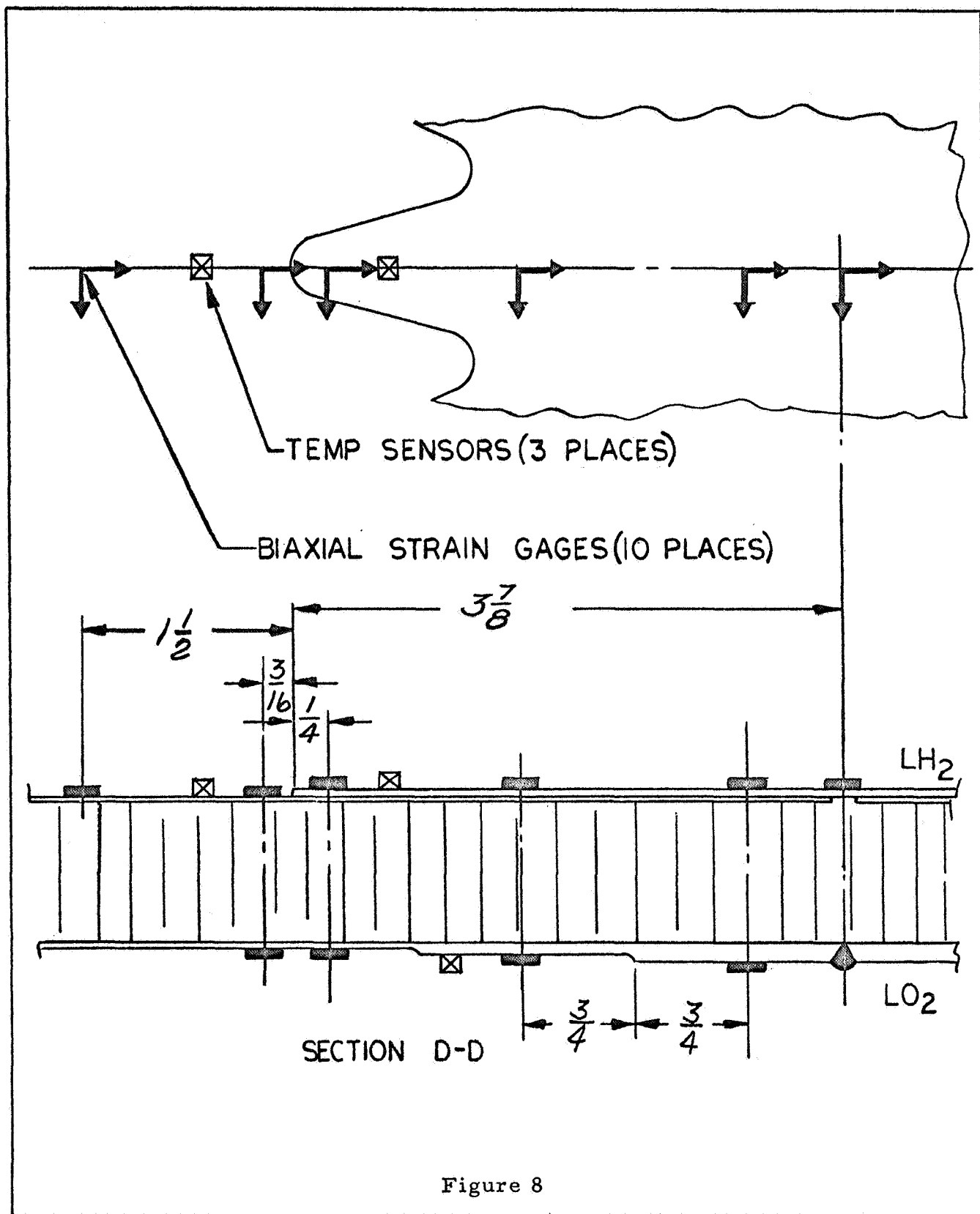
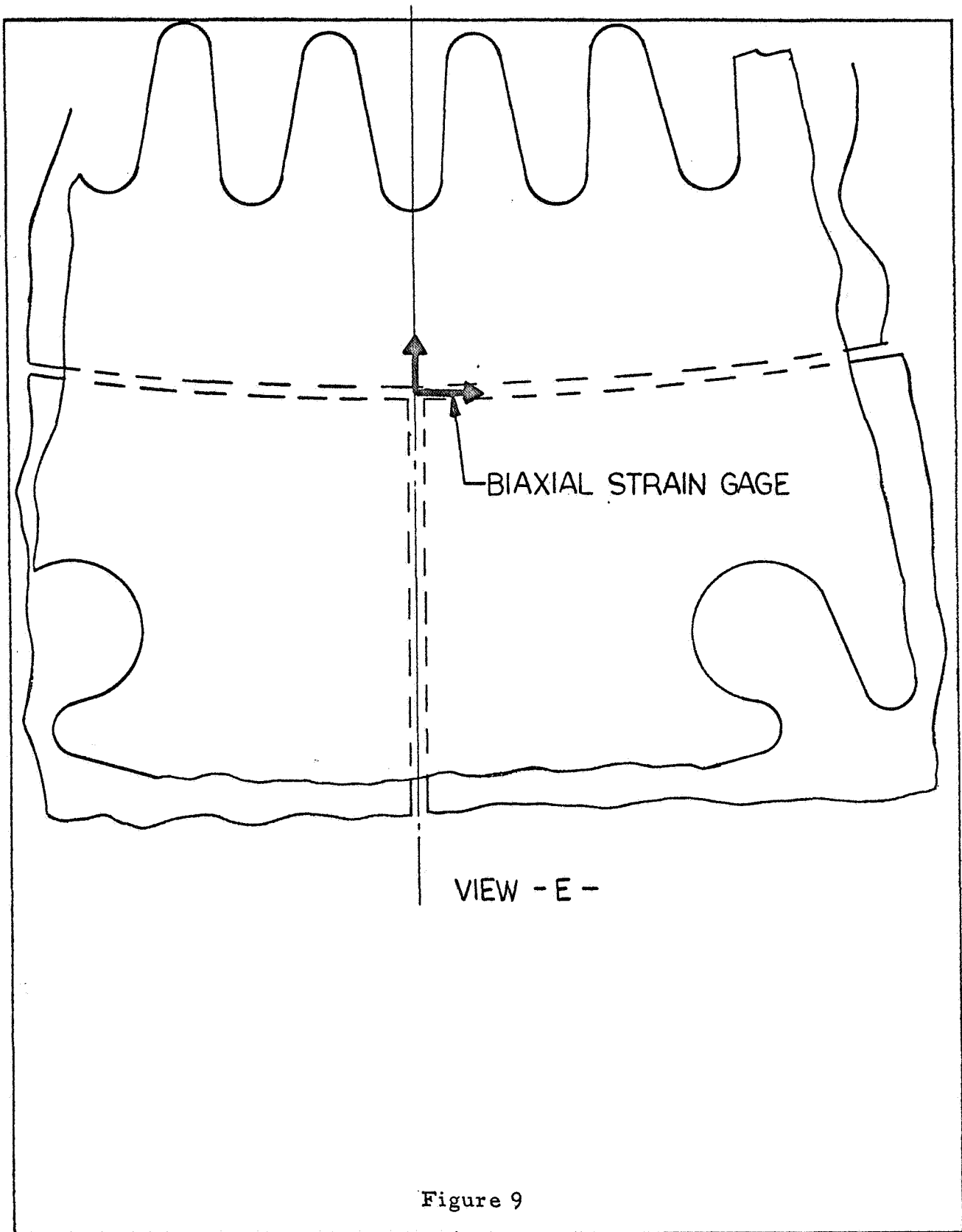
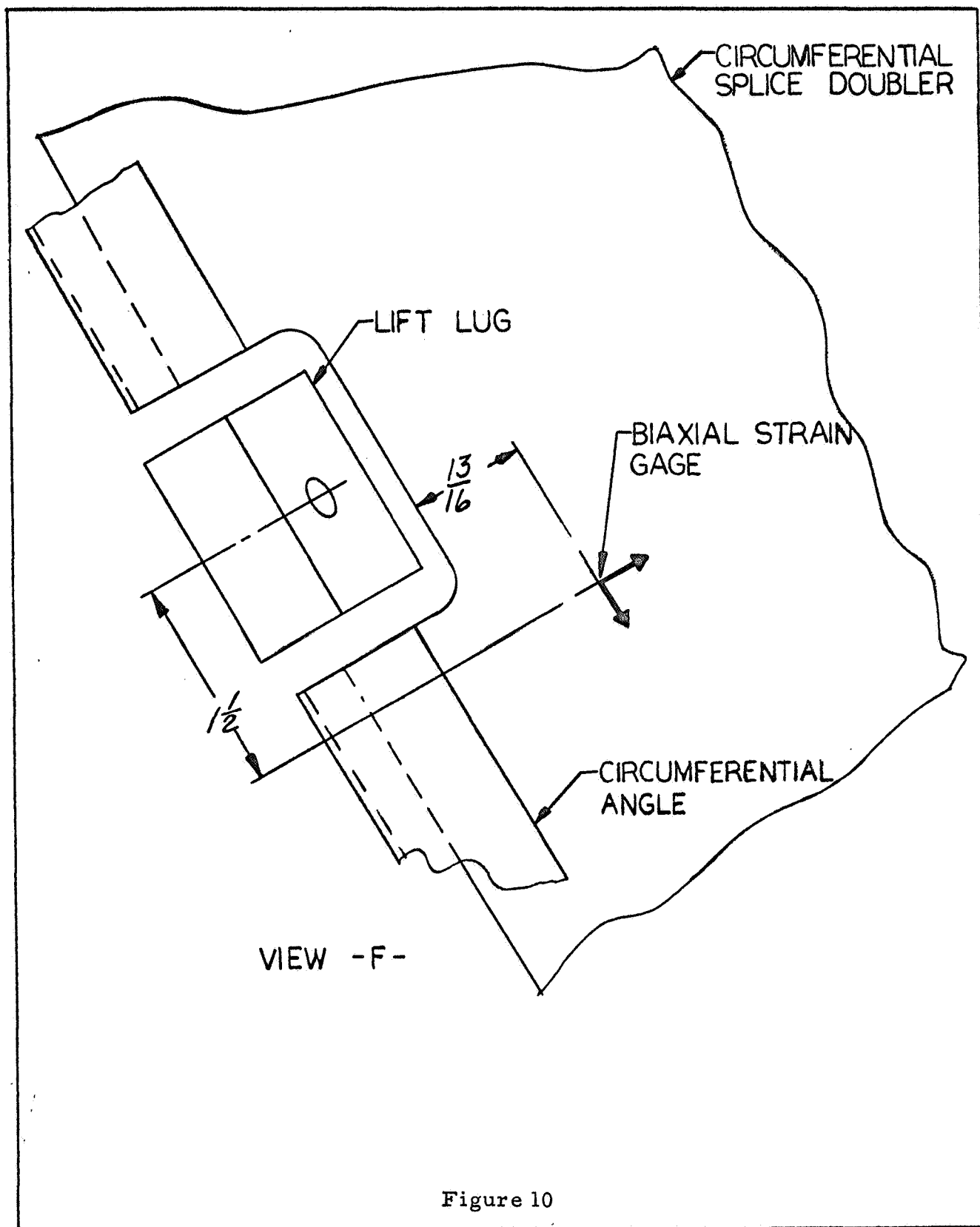


Figure 8

STRAIN GAGES AND TEMPERATURE SENSORS
AT DOLLAR PLATE JOINT



STRAIN GAGE AT
MERIDIAN - DOLLAR PLATE JOINT



STRAIN GAGE NEAR
DOUBLER CUT-OUT

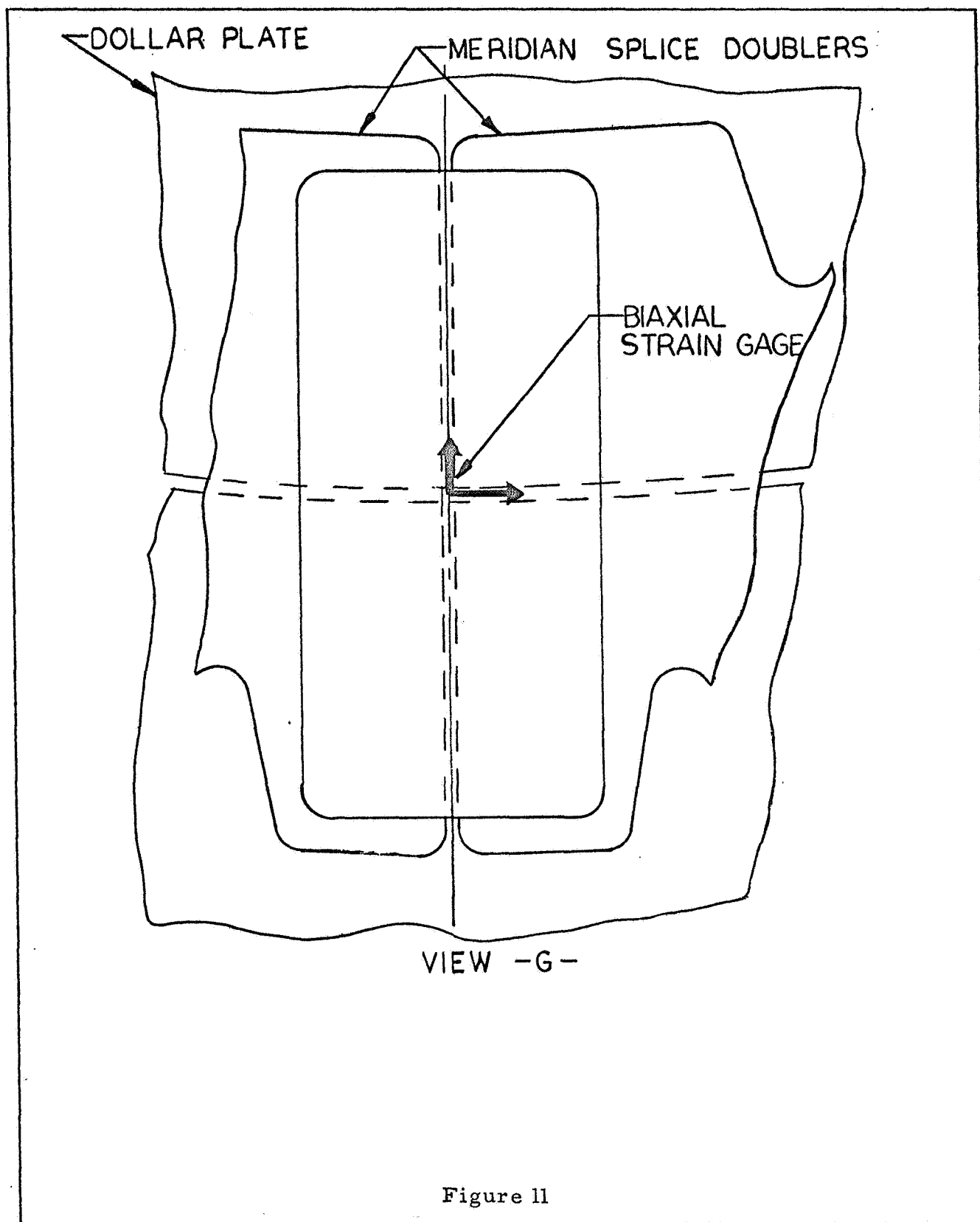


Figure 11
STRAIN GAGE AT
INTERSECTION OF MERIDIAN DOUBLERS

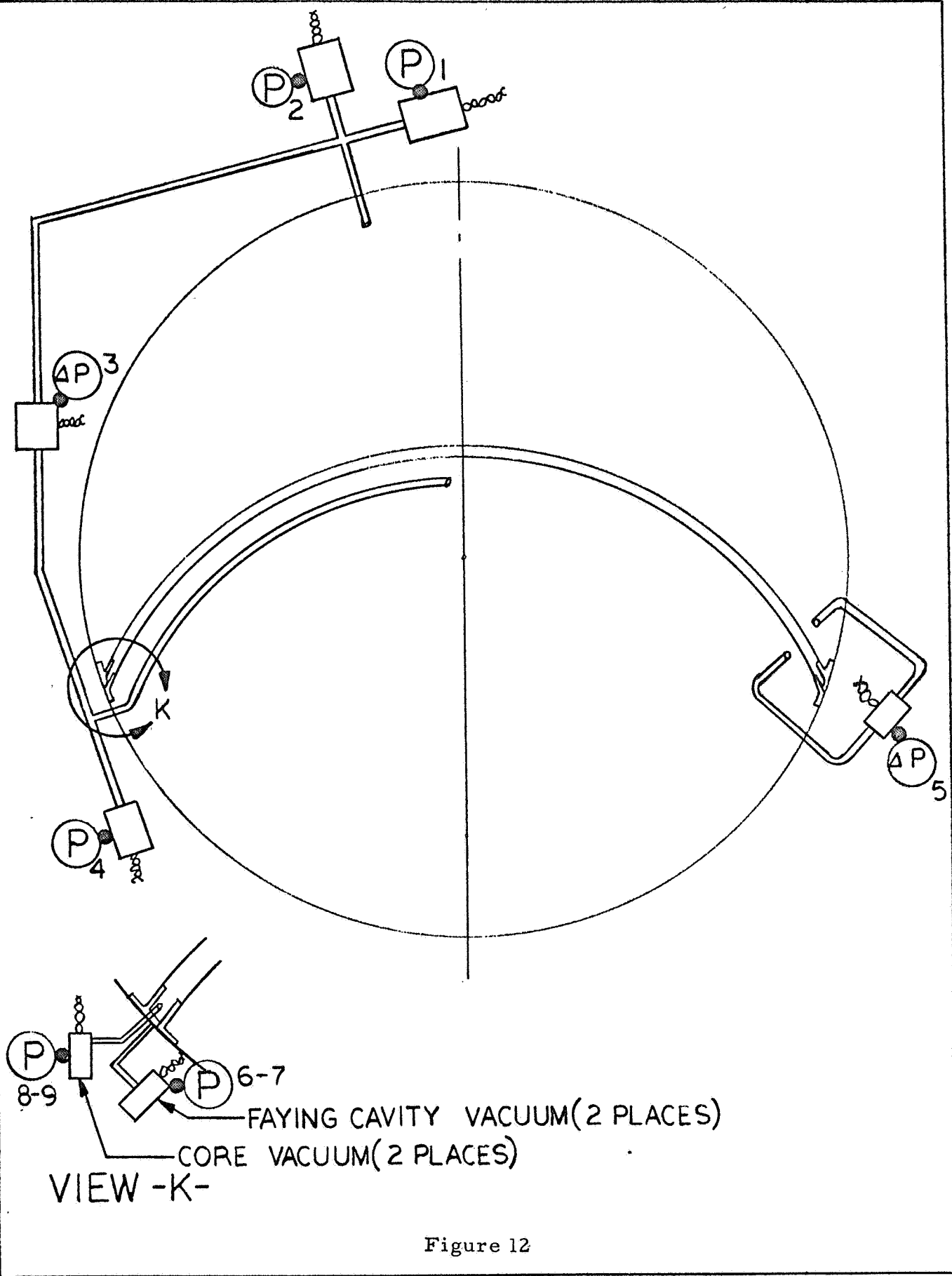
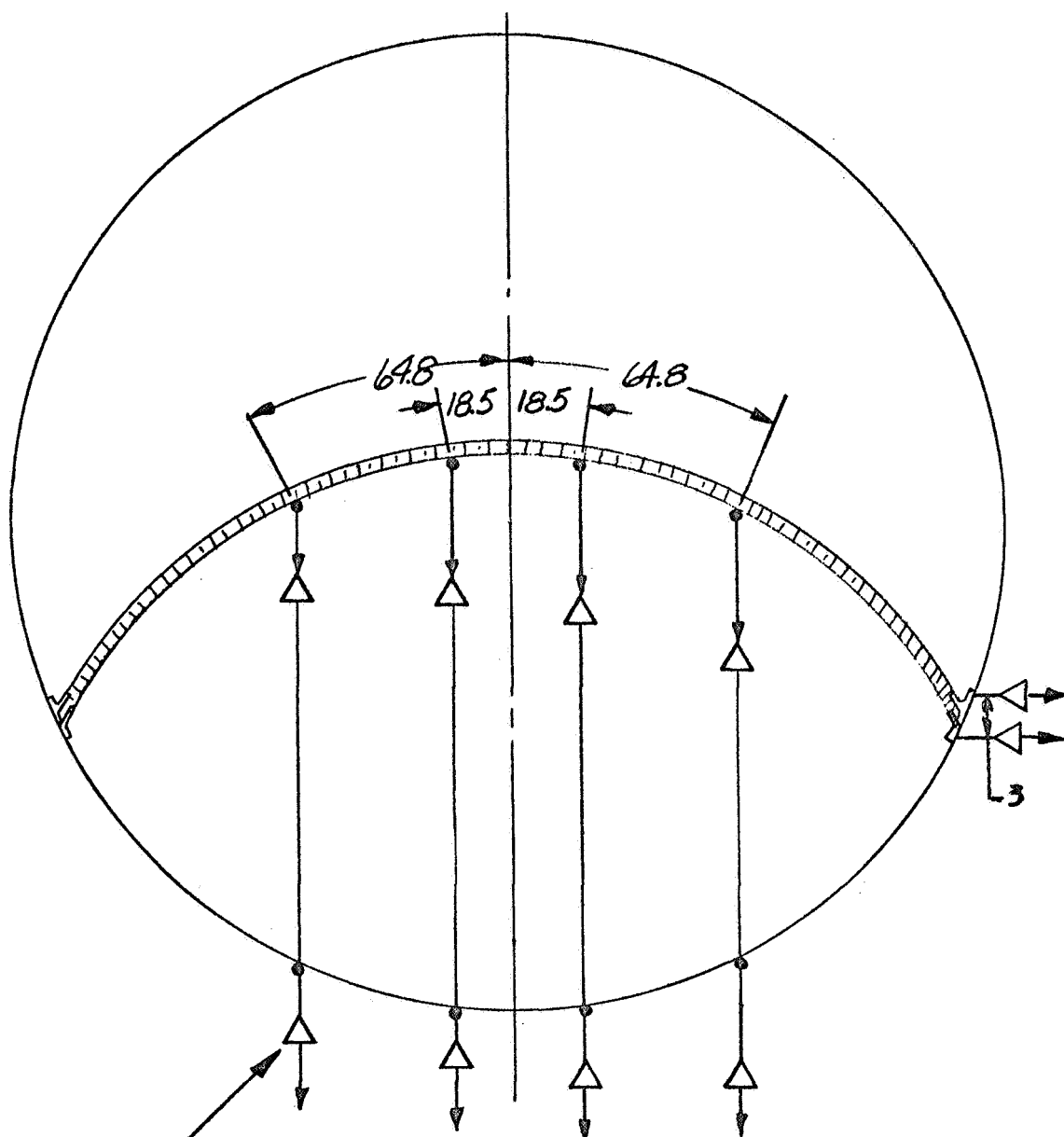


Figure 12

TEST SPECIMEN
PRESSURE TRANSDUCERS

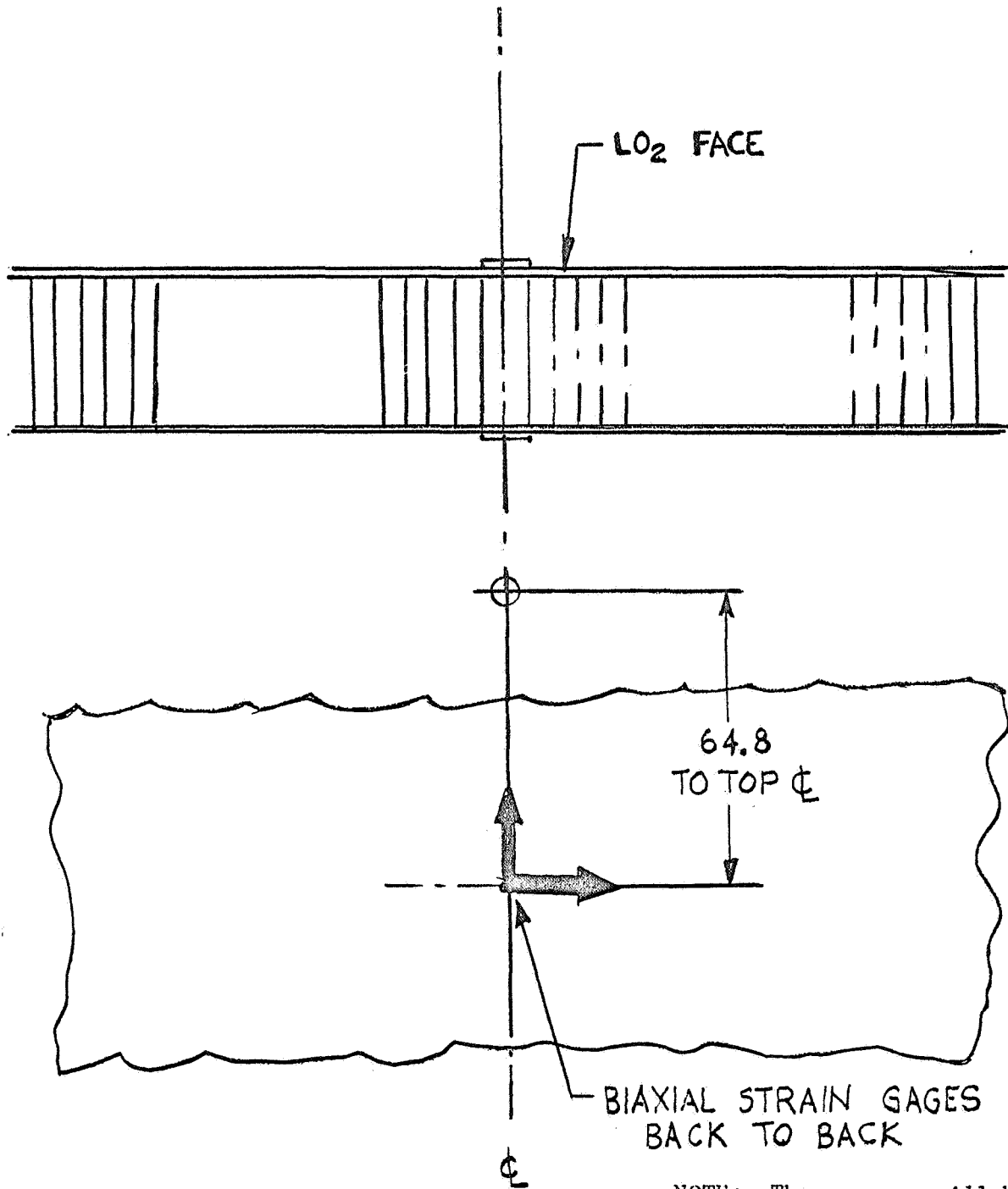


DEFLECTION TRANSDUCERS (10 PLACES)
SECTION L-L

Figure 13

DEFLECTION TRANSDUCER LOCATIONS

SECTION M-M



ϕ
OF SEGMENT
Figure 14

NOTE: These gages will be visually monitored on strip charts.

STRAIN GAGE LOCATIONS LOX AND LH₂ FACE SHEETS

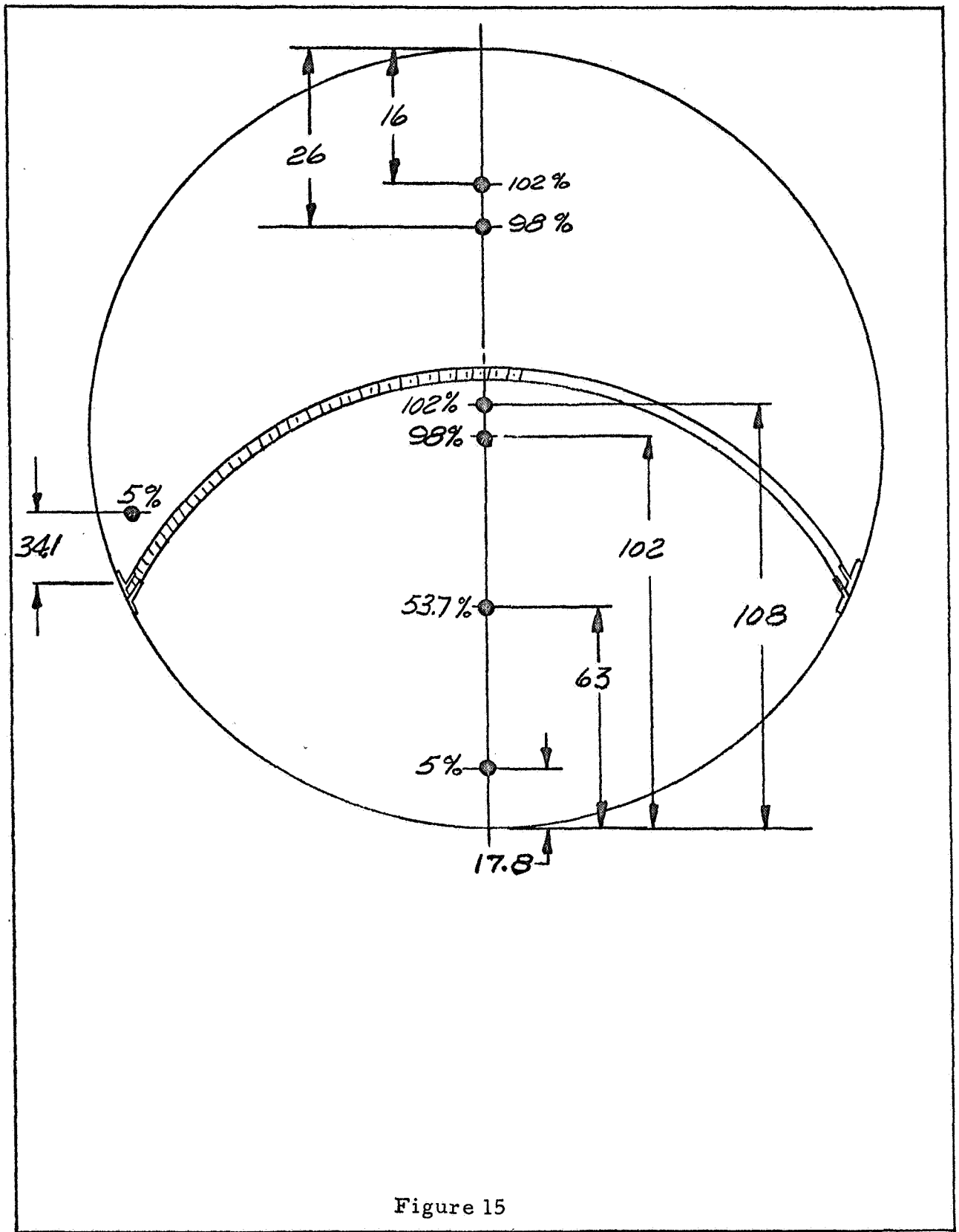


Figure 15

TEST SPECIMEN
FUEL LEVEL SENSORS

6.1.1 -- Objective 1 - Structural Characteristics

To fulfill this objective, strain gauges, deflection transducers, and extensimeters have been so located as to produce reliable deflection and strain characteristics.

Data from these measurements will be used to compare the deflections, both vertical and horizontal, with those from the standard S-IV bulkhead. Strain and stress distributions across the bonded splices of the meridian joints as well as the membrane skins to the aft attach ring will be used to determine the capability of the bond line to transfer loads efficiently from the membrane skins to the splice doublers.

6.1.2 -- Objective 2 - Structural Integrity

To fulfill the structural integrity objectives, the common bulkhead must prove capable of withstanding the critical ultimate pressure differentials with their appropriate thermal environments and still fulfill its design purposes. Permanent deformation or yielding of any portion of the bulkhead shall not be a criterion of non-fulfillment of this objective, providing it is not in any way detrimental to proper functioning of the propellant tankage system in meeting flight requirements.

At the completion of the ultimate tests, the common bulkhead test specimen will be fully inspected and essential test data reviewed to evaluate the structural condition. Primary emphasis will be directed towards common bulkhead internal pressure, tankage pressures, crack indications in the welds, the results of past-test dye-penetrant and visual inspection, and strain measurements after conversion to appropriate stresses.

6.1.3 -- Objective 3 - Ultimate Failure by Reverse Buckling

The common bulkhead, while in a cryogenic environment, will be subjected to increasing negative pressure until failure occurs. The purpose of this test is to determine the maximum capability of the bulkhead to withstand a collapsing pressure and to compare this value with a predicted value. Emphasis will also be placed

on studying the nature of the failure and to identify weak points.

6.1.4 -- Objective 4 - Leak Characteristics

Four separate systems for monitoring the faying cavity and bulkhead core cavity pressures have been provided as well as gas sampling bottles for collecting gasses leaking into the core areas. The pressures will be visually monitored for abrupt changes and during testing continuously recorded for permanent record. Gas samples will be taken before and after each countdown and during the test if necessary. Chemical analysis of these gasses will be used to determine from which tankage any leakage took place.

6.1.5 -- Objective 5 - Comparison Data

Strain gauges, deflection transducers, pressure sensors, and necessary temperature sensors have been located as nearly as possible to the same location as those on the standard S-IV bulkhead. Also, as many gauges as possible have been located back-to-back or directly opposite on the forward and aft facing skins, so as to allow accurate differentiation between membrane stresses, bending stresses, and thermal stresses. The resulting computations, therefore, can be compared directly to those made on the standard S-IV bulkhead. Also, the strain gauges around the "fingers" of the meridian and circumferential doublers can be used to determine the transfer of load from the aft to the forward skins, in the same manner as was done near the weld lands of the S-IV bulkhead, again permitting direct comparison between the two types of construction.

6.2 -- Documentation

The common bulkhead test results and test evaluation will be formally documented in a Douglas Report.

7.0 -- REFERENCES

7.1 -- Reports

1. DSV-4 Design memorandum No. 118, "Revised S-IV Propellant Loading and Draining Procedures", dated 10-29-64.

2. SM-42569, "Strength Analysis, Saturn S-IV Propellant Tank",
June 1963, Rev. November 1965.

7.2 -- Drawings

1. IT05174 - Test Vehicle - Common Bulkhead DA-103
2. IT13711 - Test Vehicle - Modified Common Bulkhead
3. IT13681 - Rework Dome Assy. - DA-103
4. IT13688 - Forward Dome Assy., Test Article
5. IT05141 - All Bonded Common Bulkhead as modified by IT013681
6. IT09389 - Instrumentation Installation, Full Scale Bonded Bulkhead
7. IT09434 - Instrumentation Installation - Details

8.0 -- DATA PRESENTATION AND HANDLING

8.1 -- Presentation

Instrumentation data recorded during the test program shall be presented in two forms: digital printout and time history curves.

8.1.1 -- Digital Printouts

All strain, deflection, temperature, and pressure levels for each condition will be furnished in digital printout. The load conditions include the pressure increments during pressurization and depressurization, plus the initial and final pressure of each pressurization or depressurization phase.

8.1.2 -- Time History Curves

All instrumentation data will be furnished in time history plots starting at the time of each countdown initiation and ending at the termination of each countdown. A record of time each significant event during each countdown shall be maintained for correlation with the data curves.

8.2 -- Data Handling

A copy of the data shall be furnished to the Advance Structures and Mechanical Department and other cognizant sections at the Huntington Beach facility 48 hours after completion of each countdown. This will

assure that evaluation of the testing can be accomplished prior to initiation of each subsequent countdown without impeding progress of the test program.



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SANTA MONICA, CALIFORNIA